Quantum Transport of Correlated Systems in Novel Devices

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Further miniaturization of devices and circuits will inevitably bring us into the realm of 0- and 1-dimensional worlds, in which quantum mechanics is expected to plays a central role. Our recent investigations have focused on the electrical conduction properties in (i) **0-dimensional quantum dots which are linked together,** enabling us to deduce **unusual properties of the electron spin**, and (ii) **metallic nanowires fabricated by a new, template technique**. This method produces 20μm long wires with extremely uniform widths below 50 nm. Metallic nanowires may be used as interconnects in nano-circuitry.

Fig. 1 highlights our observation of electron-spin physics in a parallel-coupled double-quantum-dot (a). The single Kondo resonance peak (b,lower curves) splits into two peaks (b, upper curves) when the interaction between left and right dots becomes strong. The evolution into the double peaks provides direct evidence that the electron spins, one on each dot, are becoming quantum-mechanically entangled (c). This kind of entanglement is essential for quantum computing.

Figs. 2 and 3 shows metallic nanowires deposited on molecular-beam-epitaxy grown template.

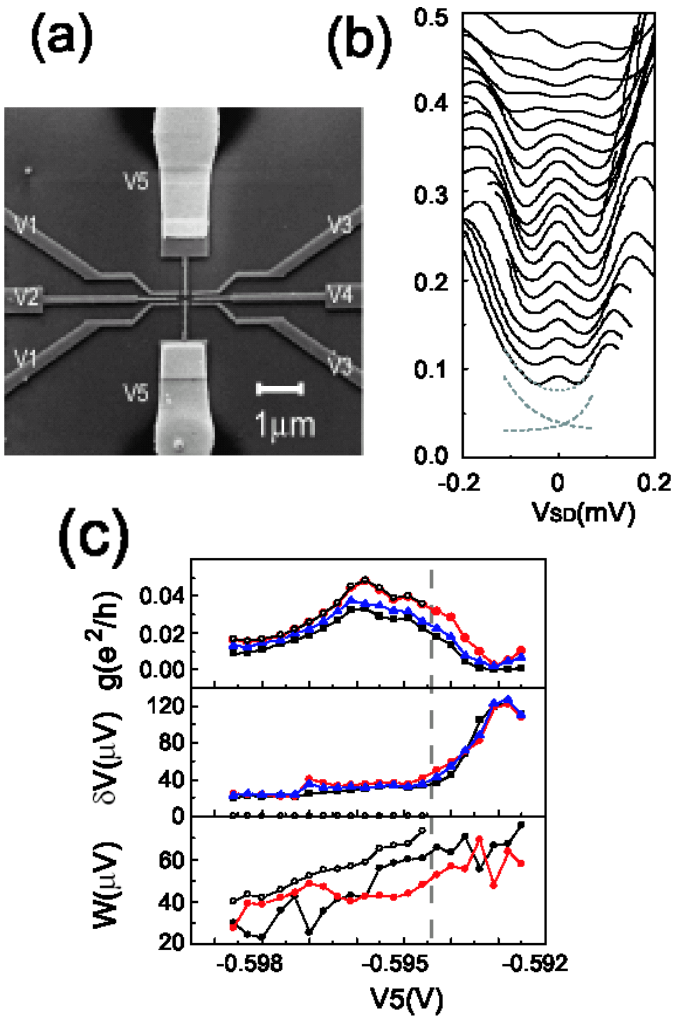

Figure 1--Spin physics and spin-entanglement in a double-quantum-dot.

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Educational:
2 grad students, 1 receives partial support.

Outreach:
Having just moved from Purdue to Duke University, I am starting to develop experiments for the undergraduate advanced lab. There will also be opportunity to interact with K-12 students.

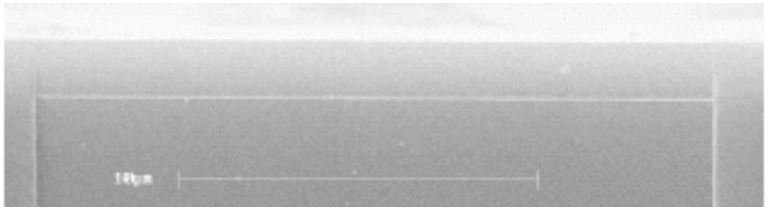
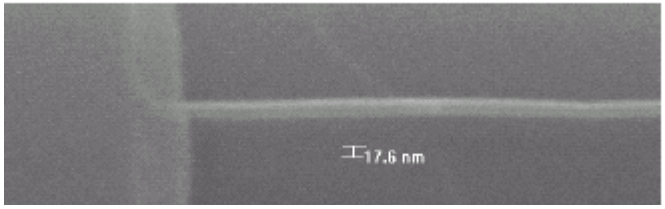


Figure 2: SEM picture of a 40nm wide Au/Pd (gold-palladium) nanowire on an InP (indium phosphide ridge. The wire is 20 μm long.



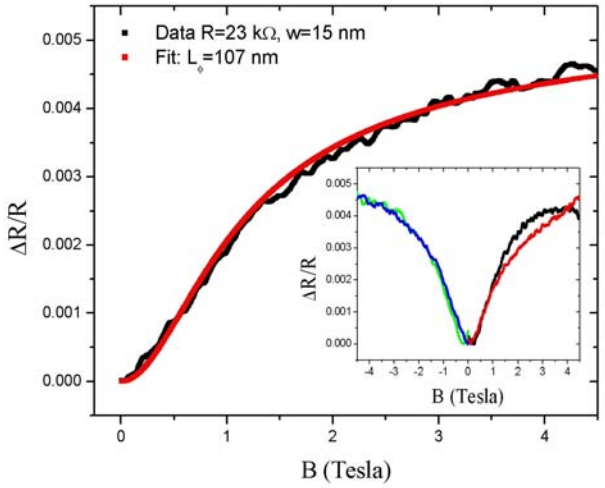


Figure 3: Top—SEM picture of a 17 nm wide, 5 μm long Au/Pd (gold-palladium) nanowire on an InP (indium phosphide) ridge. Bottom—Negative-magneto-resistance curve (black) showing the quasi-1-dimensionality of the wire. Red curve is a fit to data based on theory. Inset shows data for both + and – magnetic fields.